DOCUMENT RESUME

ED 252 672 CE 040 440

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TITLE Students, Learning and Computers: Surviving the Changes. Paper No. 513.
INSTITUTION Arizona Univ., Tucson. Agricultural Experiment Station.
PUB DATE 7 Jan 85
NOTE 22p.; Paper presented at the Regional Conference on University Teaching (1st, Las Cruces, NM, January 9-10, 1985).
PUB TYPE Reports - Descriptive (141) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Agricultural Colleges; *Agricultural Education; Case Studies; *Computer Assisted Instruction; *Higher Education; *Instructional Improvement; *Instructional Innovation; Microcomputers; Universities; *Vocational Education
IDENTIFIERS Computers in Education

ABSTRACT

The objectives of this paper are to present some approaches for using computers to aid in the teaching of students in colleges of agriculture and also to share some ideas for improving instruction in the rapidly changing computer environment. The paper first outlines a conceptual relationship among students, learning, and computers in university instruction. It examines student characteristics, teaching goals and the available means to achieve them, and educational applications of computers. The "ideals" and the "realities" of microcomputing in an instructional environment are then discussed in order to enhance the understanding of the alternative uses of computers in instruction. To illustrate one approach to moving from the reality toward the ideal, the recent efforts in the Department of Agricultural Economics at the University of Arizona to use computers as a component of instruction are described. A summary and conclusion provide some keys to surviving the rapidly changing microcomputer instructional environment, given in the form of brief rules of thumb. They include: know your students and your instructional goals, know and use your computers, use student-friendly applications software, keep it simple but push the student, let the students do the work, know the limitations, and always look for something new. (YLB)

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STUDENTS, LEARNING AND COMPUTERS: SURVIVING THE CHANGES

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January 7, 1985

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Invited Paper present at the First Regional Conference on University Teaching, New Mexico State University, Las Cruces, New Mexico, January 9 and 10, 1985.

Paper No. 513, Arizona Agricultural Experiment Station, The University of Arizona, Tucson, Arizona, 85721.

CE040440

STUDENTS, LEARNING AND COMPUTERS: SURVIVING THE CHANGES

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James C. Wade*

Introduction

In the desert beside the massive Columbia River as it separates the states of Oregon and Washington, computers on large commercial farms daily call a computer at the local electric cooperative to determine the appropriate quantity of irrigation water to apply to the farms' crops. The quantities of water are optimized daily considering the age and type of crop, past irrigations and the recent local weather history. The cooperative receives satellite weather data periodically throughout the day from its solar powered weather station located among the farms. The data required for complex water management decisions are collected, analyzed and distributed on the cooperative's microcomputer and are processed on using similar computers. In Colorado and Nebraska, computer controlled irrigation management systems actually turn on and off the irrigation pumps to take advantage of time of day electricity pricing (Duke, et al., 1984).

These are not futurist views of agriculture. These and other similar applications of computers promise to create major changes in agriculture. American farmers have traditionally been rapid to adopt new production technology such as mechanization, hybrid seed and agricultural chemicals. Such adoptions have made American agriculture a model of efficiency (Thurow,

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1983). Sonka (1983) identifies three major revolutions in agriculture: substitution of animal power for human power, introduction of mechanical power and adoption of chemical-backed techniques, and emphasis on business and financial management for farm growth and/or survival (the information age in farming). Information based technological changes are already making significant changes in agriculture as the demand for important decision making information grows. Farmers are both consumers of outside information and suppliers of the internal information services required for effective business management. New agribusiness and government sectors are emerging to help provide computer and information services needed in agriculture. Knowledgeable and successful users of such information services increase their likelihood of survival in the competitive farm sector.

Although many anticipated computer innovations may be years away, recent changes are having major impacts on teaching. Educational institutions are pressed to produce students with at least the rudiments of computer knowledge, whether the student will work on the farm, in agribusiness or in government. Colleges of Agriculture, like other educational institutions, are searching for the best instructional uses of computers in their varied undergraduate and graduate programs. Rapid changes in the computing environment and insufficient experience and exposure of newly graduated students increase the urgency of the transition from traditional methods of teaching toward those that integrate computers into the overall teaching process. Students with better computer and information management skills increase their opportunities to survive and prosper in the food and fiber sector of the information age.

Economic survival in agriculture depends more and more on obtaining and successfully processing the information sufficient to assure a comparative production and marketing advantage. Table 1 lists some of the areas in which

Table 1. Information Environment in Agriculture

Marketing Information	**Production Decision Making**
Output Price Access	Crop Mix
Customer Access	Input Timing
Availability of Inputs	Production Risk
Input Prices	Feed Mix
Weather Impacts on Markets	
Market Strategies	**Extenstion Information**
News Related to Marketing and Production	Technical Advising
Inventory and Storage Control	Market Information
	Scientific Control of Complex Process
Financial Management and Accounting	Milking
Record Keeping	Irrigation
Cash Flows	Feed Mixing
Cost Accounting	Information Handling
Cost Budgeting	Input Monitoring
Investment Analysis	
Payroll	

computers have been, or may be, of considerable benefit in farming. Other applications exist for the much larger agribusiness and related government sectors. It is readily apparent that most of these impacts are in the area of business management decision making, which directly impacts on the instructional programs of Departments of Agricultural Economics and Agricultural Business.

Providing agricultural students with a foothold in, and helping them become efficient participants in, the society is the goal of all instruction in Colleges of Agriculture. Increasingly, this goal requires knowledge of the functions and uses of information and computers in business management and economic policy analysis. The "information age" is upon University instruction.

The objective of this paper is to outline some approaches for using computers to aid in the teaching of students in Colleges of Agriculture and to share some ideas for improving instruction in the rapidly changing computer

environment. The fundamental assumption of this paper is that computers are not the end but the means in educational computing. They are not a substitute for classroom teaching, but an aid in gathering and processing information that leads to effective knowledge of computers and how they may be used to solve problems, especially those of agricultural economics and agricultural business management.

This paper first outlines a conceptual relationship among students, learning and computers in university instruction. Next, the "ideals" and the "realities" of instructional computing are discussed. A prospective on moving from the reality toward the ideal is then developed from the author's Department's experiences in "muddling through" the changes. A summary and conclusion provides some keys to surviving the rapidly changing microcomputer instructional environment.

Students, Learning and Computers

The three most important aspects of computers in instruction are students, learning and computers. Bringing students to knowledge is the focus of all education. In this case, the goal is to integrate the use of computers into the education process.

Students

Students are, of course, the recipient of the instructional process and few university instructors misunderstand this idea. Students are why teachers and universities exist. But, to put students into the context of this discussion, some of their characteristics must be recognized. First, students in most academic areas have not come to the university primarily seeking an education in computer applications or computer science. Otherwise, they would have chosen those areas of specialization. Students in Colleges of

Agriculture, to some extent, are interested in the applied biological aspects of plant and animal production, in the technical systems used to manage these biological systems and/or the social and economic environment in which these processes are taking place. These students are not, and do not want to be, computer scientists. Students in these "non-computer" fields are, however, aware of the increased role of computers in the "information society" and that students in areas of study more directly related to computers (and engineering) have better job opportunities. Many of these same students have limited quantitative skills and, perhaps, even a bias or fear of computers and quantitative work. A few students view working at a keyboard degrading and mindless. Others recognize the benefits of knowing and applying computers in the chosen course of study but do not want to be burdened with the details of computer operations and programming. These students want and need to know how to use computers to supplement their applied discipline.

In summary, students are not as qualified as instructors might like but they are interested in learning to effectively use computers in their chosen area of study even though they may have no real idea what that learning might entail.

Learning

Having briefly examined students, instructors wishing to use computers in an educational program must examine their teaching goals. Once the goals are firmly established, means of achieving those goals may be defined to include computers. Table 2 gives a partial list of the areas in which the computers may aid in university instruction.

In the disciplines underlying applied biological, physical and social science education, abstraction and theory of complex ideas play major roles in

Table 2. Roles of Information and Computing in Non-Computer Oriented Instruction

Provide supplemental instruction (Tutorals)
Provide supplemental drill
Provide access to supplemental information
Provide examples
Provide easy anaysis of alternative solutions
Solve complex problems with large computing requirements
Knowledge of the role of information
Experience with computing environment
Testing
Accurate visual presentation
Hands-on experience

establishing a learning environment. Some such abstractions are never more than that to most students. While others may be developed into immediate and long lasting applications. Indeed, a common complaint of students is of a lack of usefulness of the ideas provided in, for example, economics classes. Clarification and utilization of abstraction and formal decision rules through examples, drills and exercises are, indeed, often a major portion of most educational programs. Applications have always been the key distinction in the linkage of complex ideas to agriculture since the goal is to efficiently produce the crops and animals required by a growing society. For this reason, agricultural education has always placed a strong emphasis on laboratories and field trips in its classes.

"Learning by doing" is one of the oldest maxims of education. The concept of applied/hands-on experience is a primary component of modern learning systems, especially in the sciences and agriculture. Laboratories have become an essential element in the continuing scientific revolution. The fundamentals of theoretical and conceptual analysis and the factual knowledge provided in classroom lectures notwithstanding, the practical experience of "doing" is essential to the precepts of beneficial education. The subject may

be writing, mathematics or technology. Inexpensive computers and related electronic technologies have the potential to influence classroom applications by providing more opportunity to apply the knowledge learned from conceptual analysis.

Facts, another mainstay of education, if presented in a void of conceptual ideas, provide little opportunity for learning. Data may be increased, but useful information and knowledge may not be increased. Integration of concepts, theories, hypotheses, inquires and information are at the heart of modern learning. Separating, categorizing, and utilizing important information is essential in testing and applying conceptual ideas. The drudgery of such work is reduced by the supplemental use of computers.

Thus, a summary question is "What are the goals for using computers in instruction and do they blend into the overall objectives of learning?" Is the goal to supplement teacher and tutoral shortages by substituting computers? Is the goal to teach basic computer use and programming? Are computers to store and retrieve data and information? Are computers to be used to clarify abstract conceptual ideas through applications, demonstrations and examples? Some (e.g., Litzenberg, 1982) assert that computer programming is a prerequisite for computer based learning and that computer literacy requires a knowledge of how computers function and how software is designed. Are these requirements part of the goals of instruction in the parent discipline? And finally, can learning of the central elements of the discipline be improved using computers? If not, then compuers may not be needed in instruction.

All of the computer uses suggested in the previous paragraph are valid to some degree. However, in agricultural economics, the primary goal is to train

knowledgeable decision analysts and decision makers, whether they are producers, agribusinesses, or resource or policy analysts. Computers are simply tools for aiding this process.

Computers

The evolution of computing hardware and software are the factors that give impetus to the urgency of the questions addressed in this paper. In less than five years, the computer industry has been revolutionized and the concept of personal computing has become a reality. Problems that only a few years ago would have required a large mainframe computer now can be solved efficiently using "desktop," or even "kneetop" computers. Computing power is in smaller, cheaper, and easier to use packages.

A software revolution is following the hardware revolution and software ultimately provides the key to educational use of computers. Applications software design has dramatically improved over the past year. Integrated word processing, spreadsheet and graphics systems are readily available (although not always inexpensive) for almost every make of microcomputers. Decision aids and information handling software for various applications, from accounting to statistical analysis, are expanding rapidly. As availability and competition expand, prices decrease and capabilities increase. These software aids, designed for efficiency by knowledgeable computer users, utilize the full power and promise of microcomputers by using efficient data handling, interactive computing and full screen graphic display. New software is designed to be as "transparent" as possible for the user. As a result, user burden is minimized.

Rapid change in computing hardware and software is the current and foreseeable state of the art. Hardware or software purchased today is

superceded by more powerful and cheaper versions in just a few months. Stabilizing instructional computing in such an environment is, at best, difficult especially for a faculty that is primarily interested in the concepts and applications of their discipline. Generating new and truly unique computer applications for instruction is all but impossible. Just keeping up seems impossible. Many faculty simply will not bother.

The availability of powerful, inexpensive computing aids the underlying concept of the educational process by allowing students to have meaningful hands-on experience at a relatively low cost and with considerable ease. It is tremendously important that at least some instructors lead the way in developing solid educational applications for microcomputers in disciplines where they enhance existing educational goals. By briefly examining the "ideals" and the "realities" of microcomputing in an instructional environment, this paper seeks to enhance the understanding of the alternative uses of computers in instruction.

The Ideal Instructional Computing Environment

Proper integration of students, learning and computers should lead to an ideal instructional computing environment. The key elements of this environment for non-computer disciplines are outlined in Table 3. The ideal operating environment is largely transparent to the student and the instructor. In such cases, the student has a knowledge of the basic operational procedures of, and some experience on, the computers available. A previous fully integrated and coordinated course of studies has prepared the student to use microcomputers, at least to a limited extent. The student knows how to efficiently use the keyboard and has no inherent fear of computing. The student understands the basics of mathematics and equation

Table 3. Ideals for a Computer Instruction Environment

Student Literacy	Well Structured Software
Knowledge of the Basics	Drills and exercises
	Tutorals
Well Integrated Educational Goals	Computer Literacy
Administrative Support	Concepts and Theories
Conceptual Integration	Introduction to Software
- Innovative and coordinated goals	Problem Solving
Knowledgeable Administrators	Statistics
Support Personnel,	Spreadsheet
Supplies and Maintenance	Operations Research
Software	Financial Analysis
- Innovative and coordinated to goals	Accounting
Student Access	
Hardware Availability	Instructors
- Compatible and inexpensive	Know Concepts
Small Groups	Know Software Use
Software Availability	
- Compatible and inexpensive	

structure. In short, basic computer literacy already exists so that the operational aspects of computing need not be retaught. All students are be more or less at the same level of knowledge.

The ideal computer facility, or laboratory, is supplied with up-to-date microcomputers including, at least, a printer and for each computer, graphic video output. Memory and data storage devices are adequate for the largest software requirements. Each machine has a telecommunications access to data utilities and other outside larger computers. A sufficient number of identical computers are available. Few, if any, students are waiting to use the computers. The laboratory is spacious and pleasant. Machines and students are placed so that distractions are at a minimum. Conflicts of time and space do not exist.

In an ideal instructional environment, administrators at all levels, from Department Heads to the Legislators, are knowledgeable of, and appreciate the use of, computers as intructional tools. Adequate support personnel, supplies

and maintenance are provided. Instructors are rewarded for innovative teaching in a well understood and coordinated way. No conflicts exist as to which departments are to teach which materials and maintain computer laboratories. Every department that wants a laboratory has unlimited access to one.

Software, the brains in the ideal computer laboratory, is easily chosen from that readily available in the software market and funding exists to purchase, in large quantities, the exact software needed for each instructional goal. If not available on the market, an expert programming staff is available to design the needed software. Drills, exercises, tutorals, and problem solving units are precise and serve exact educational needs. Instructors are fully knowledgeable, do not make mistakes, and integrate the software presentation into other material given the student.

The "Ideal Instructional Computing Environment" is, of course, only a goal. Perhaps, the "ideal" presents nothing more than the way changes may ultimately provide for future instructional computer use. In the meantime, instruction is carried out in a more "realistic" environment.

The Real Instructional Computing Environment

The "real" instructional computing environment is much the opposite of the "ideal" presented in the previous section. Demands from students, parents and administrators seek increased and improved computer skills without providing the resources needed to meet these demands. Like other laboratory sciences, the benefit of computers in instruction is in the hands-on experiences of the students. However, computer laboratories for instruction are assumed by some administrators to be necessary for "computer sciences" and "engineering", but not for other academic areas. Such laboratories, if ever

built, are assumed to retain their usefulness almost indefinitely and are costless to maintain. The rapid change in software and hardware is not fully acknowledged. Computing laboratories are expensive to establish, supervise and maintain. Space is usually limited.

Thus, the instructional laboratory in a "non-computer" discipline, in reality, is a few (if more than one) microcomputers or mainframe terminals in a small unused storage space or in a faculty member's office. Cramped conditions endanger equipment and limit learning potential. Limited equipment create over use further shortening the useful life of the equipment. Graphics presentation may not exist, or is very limited, and printers are often inconveniently shared. Telecommunications is restricted or nonexistent.

Many students enter courses that use microcomputers with little or no previous training. The instructor teaches "computer literacy" and, thus, removes a bit of material from the original planned course outline. Many instructors find the benefits of computer base instruction large enough to warrant the rescheduling of other activities. Instructors often lack knowledge of the potential uses of computers in instruction, of the method of coordination of computer aids into their instructional goals and of the available software for their application. A majority of instructors could not, or would not, write software for such computer based applications. Knowledgeable programming or teaching assistance is rarely available. Little or no academic recognition is provided for innovative teaching and software design in most large universities.

Software cost is high, especially if several different software packages are being used in a computer laboratory. Of course, software packages are not directly available for many conceptual ideas of primary concern. Software application is the central focus of instructional computing. If instructors

are waiting for an ideal software package to aid the learning of difficult concepts, the wait may be quite long. In fact, the instructor may need to write, or hire a programmer to write, a program if the software need is ever to be fulfilled. Funds for such activities are limited.

Although limitations on software for university level instructional use appear to be very severe, these limitations are primarily in the areas of preprogrammed tutorals, drills and examples. Software markets have greatly improved for business and accounting, statistical and operations research software. These, usually expensive, softwares are often discounted in volume to educational users and provide an ideal base from which to develop the types of educational application that best fit many university instructional environments.

Given the realities of the instructional computing environment, what approaches are appropriate and how can they be implemented? To illustrate one approach, the following section describes the recent efforts in the Department of Agricultural Economics at the University of Arizona to utilize computers as a component of instruction. Efforts that are less than perfect but efforts that provide a beginning.

Muddling Through: A Case Study

To place some prospective on the potentials of and approaches to microcomputer in instruction, the Department of Agricultural Economics at the University of Arizona is used as an example (see Wilson, 1984). The Department has approximately 28 microcomputers to service 16 full-time faculty plus support staff in teaching, research and extension. Microcomputers are an important element of office productivity and the research and extension programs of the Department. Additionally, eight of the 8-bit CP/M based microcomputers are dedicated to instructional use.

The Department's 22 courses are taught once each year. Class sizes are relatively small, ranging up to approximately 60 students. Twelve faculty positions provide full-time equivalent instructional faculty of approximately 3.12 faculty years/year. The Department has one half-time teaching assistant who works primarily with computer oriented courses. The Department has 27 graduate students. The Department services some instructional needs for other departments of the University. Instructional computer use is carefully limited to a role of supplementing existing courses in Farm Management, Financial Analysis, Production Economics, Agricultural Marketing and Demand Analysis, and Applied Operations Research.

The last two of the courses listed above are graduate courses and reflect the traditional linkage of computers to applied research in agricultural economics dating back some 20 or more years. Graduate instruction traditionally includes at least some instruction in, and experience with, computer software and, to a lesser extent, computer programming. Particular applications center on statistical analysis (including econometrics) and mathematical programming. At the University of Arizona, graduate class sizes are relatively small (10 to 30 students) providing for significant individual instruction.

The traditional approach to graduate instruction has been to assign students small to moderate size problems for analysis. The students are given minimal instructions of data entry and formating and are left to determine how the problem is to be solved using the assigned software. Students must setup the problem properly, convert the problem to the nomenclature of the available software and produce and analyze the solution. These computer related assignments have primarily been in the areas of mathematical programming. The software interfaces have been primarily through batch card entry since student access through timesharing is somewhat limited and cumbersome. In recent

years, some of the data management and other functions of instructional applications have been shifted to timeshare/ interactive computing on moderate to large computers which serve as "frontend processors" for the large mainframe computers. The students correctly perceive this approach as antiquated and resist learning such processes. Many have never learned to use a card punch or card reader and see little need in doing it now. Experiments using timeshare systems as frontend processors for the batch input have proven less than satisfactory since few students have experience with line oriented text editors.

Although this traditional approach is limited, substantial learning in problem applications is accomplished. The transition from batch to timeshare to microcomputers is underway but limited by available applications software and timeshare access. It seems appropriate to jump over this stage and move directly to microcomputing as a substitute.

Formal microcomputer use in graduate courses has, thus far, been limited to a few test cases in linear programming and statistical analysis. However, for many applications at the graduate level, efficient software for microcomputers is just now becoming available. As microcomputer/software capabilities improve, all but the largest statistical and operations research applications will be solved using microcomputers.

Graduate student learning on microcomputers is a more informal process. Most graduate students see immediate applications of microcomputers for word processing of papers and theses, and some for other applications. The microcomputer laboratory (including some additional machines dedicated to research) is made available to graduate students without supervision on essentially an unlimited basis. Thus, students recognizing the potential cost savings of the word processing teach themselves. Ultimately, they learn software necessary and valuable for carrying out thesis research. A few even

learn to program in the languages available to them, although learning to program is not usually necessary. This informal learning is an important aspect of graduate training.

Computer applications in undergraduate instruction have historically been less because of software complexity. Some of the applications software used in graduate courses and in research has been used with limited success at the undergraduate level. Because of required background and experience to run large mainframe software packages, these software applications at the undergraduate level have been met with mixed results. The applications and software are simply more advanced than needed at the undergraduate level. Microcomputers are changing this complexity and providing significant opportunity for increased instructional applications.

In the Fall of 1982, the first attempts were made to use microcomputers as an aid in undergraduate teaching after the Department received a small gift from CALCOT-Seitz Foundation to purchase a few portable microcomputers for instruction. Although the computers arrived later in the semester than was desirable, some applications were developed and successfully carried out in this first semester. Several factors, besides the late arrival of the computers, affected the first attempt to use the microcomputers to supplement classroom instruction. First, since adequate space was not available to establish a student laboratory, the instructors attempted to setup the microcomputers during regularly scheduled classes. The computers had to be removed immediately following the class. This idea seemed reasonable since the computers were portable. For introductory instruction, this arrangement was adequate, although additional personnel were required for equipment setup and monitoring. The most limiting part of move-in/move-out instruction is that it does not provide "out-of-class" access to the computers so that each

student may spend some hands-on time learning the functions of each key and the subtleties of the software and to experiment with applications.

Although student enthusiasm was high and some learning of microsystem and software applications did occur, the overall experience called for a change. For the second and third year, a small microcomputer laboratory has been established which provides students with substantial time (7 hours per day) for experimentation and applications. Although the laboratory is cramped and access limited to eight microcomputers and two printers, this laboratory is proving a popular addition to the Department's instructional program.

The instructional goals and the approach to computer use in the Department are to use microcomputers and, with preprogrammed software, to aide in solving problems of interest in Agricultural Economics. The computers are used as laboratory tools and their use is flexible within the context of available software. Since emphasis is placed on applications, minimum start-up instruction is required and students can be involved in applications of their own within minutes of first coming in contact with the computer. To break the computer ice and to put the students at ease at the keyboard, initial applications are to type a business letter or research report using word processing software. A tutoral program is available on the word processor and students are given an instruction sheet with which to get started. Each student is required to provide their own applications diskette. Perfection is rarely obtained on the first exercise. But, as experience and acceptance increase, class assignments improve in quality of presentation and analysis. Additional assignments in the undergraduate courses include designing spreadsheets to coordinate data and to analyze farm management problems such as farm enterprise budgeting, cash flow analysis and capital investment analysis. Students are not given spreadsheet templates

into which they simply plug numbers. If they are to successfully apply microcompuers when they leave the University, they must know the basics of software structure and applications. Computer programming is not taught but software applications are taught within the full context of the software. This approach, although more difficult for instructors, is proving beneficial for students.

In more abstract courses, such as Production Economics, spreadsheet analysis is used to augment the learning of decision processes involving production functions, budgeting and time value of money. In addition to spreadsheet software, applications are also developed on preprogrammed software for investment analysis and linear programming.

The experiences of the Department and the faculty most directly involved in computer use in instruction have been mixed. The faculty sees good potential for improved student learning of fundamental concepts. The transition from mainframe to microcomputer has not been easy and is far from complete. As the faculty learns the benefits of microcomputing, objectives must be clarified, capable teaching assistants must be acquired and software must be evaluated, purchased and applied.

Keys to Survival

In summary, microcomputers for instructional use are still primarily a promise in most university applications. Junior and Senior High Schools are often better equiped for providing microcomputer instruction than are universities. Perhaps much of the basic instruction in computer literacy should be left to secondary schools and community colleges. However, university instruction can profitably use microcomputers to enhance the learning experience by using them as tools to aid students learn applications of primary concepts. The reality of resource shortages, indifference and

resistence to rapid change can be overcome by individual departments and instructors who struggle to survive in the microcomputer instruction world.

Some keys to surviving the changes are briefly outlined below:

1. Know your students and your instructional goals. For educational goals, like all other goals, getting there is more difficult if you don't know where you are going or the vehicle which is to be used. Understand student needs and wants. But don't compromise on sound instruction of basic disciplinary knowledge.

2. Know and use your computers. Instructors must know their equipment and its uses (including software) to be able to recognize new opportunities for application. Those who know are better able to teach. Teaching by example is easy in computing. Be involved in all aspects of the computing exercise.

3. Use student-friendly applications software. Learning concepts is much easier when students do not have to overcome a lot of user burden to apply the software. Emphasize applications software that is easily applied to the overall instructional goals. Don't teach computer programming. Do provide the students with help.

4. Keep it simple but push the student. Place problem solving and concept applications as near as possible in a real world context. Students working alone may have difficulty handling the data and calculations. But, students, microcomputers and software can handle a lot more data and calculations. Students' use of the software should be simplified, but not below the student's capabilities.

5. Let the students do the work. Some students learn faster than others and sometime equipment, software and students take some time to ripen. Be patient, flexible and let the students do the work. Let students use software to create their own spreadsheets and solution files for problem analysis. Make the students work for answers. In this work learning occurs.

6. Don't lie and be willing to admit a mistake. Don't oversell students on the computer's capabilities. They will only be disappointed. Let them know early that computing takes work, but that it usually is rewarding. If you make a mistake, admit it. Neither computers, students nor instructors are perfect.

7. Know the limitations. Not every computer can do the same tasks, neither can software or instructors. Not every application should be solved on a computer. Don't push beyond the limits. Don't write software, use software.

8. Always look for something new and upgrade. Keep checking with friends, colleagues, dealers, journals and magazines for new applications for software and hardware. Search out the alternatives. Do example problems and experiment. Be ready to change.

9. Find the money somewhere. Microcomputing is expensive and the funds are not always available in standard instructional budgets. However, other sources of funds or products exist. Hardware and software producers often reduce the price or give equipment to universities, especially for classroom users. They fully recognize the market enhancement of educated computer users. If computer instruction is an important part of the educational goals, push for the resources needed to enhance the goals.

Change is reality. Information, knowledge and learning help the world deal with change. The universities' goals are to improve the understanding and application of knowledge to the realities of the world. Computers in instruction can make this process much easier.

Students who have learned their lessons are able to leave the university and use the microcomputer tools available to help solve the decision problems facing them in business, industry or government. A computer is but an aid. Basic knowledge must be instilled in every student, whether or not computers are used in instruction. The computer must never become the end.

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